

# COAL IN A SUSTAINABLE SOCIETY

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Sustainability is not a fixed state of harmony, but rather a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change, are made consistent with the future as well as present needs [World Commission on Environment and Development, 1987].

The challenge for coal is to efficiently manage the resources on which community depends in accordance with the principles of sustainable development, and to reduce greenhouse gas emissions and other environmental impacts.

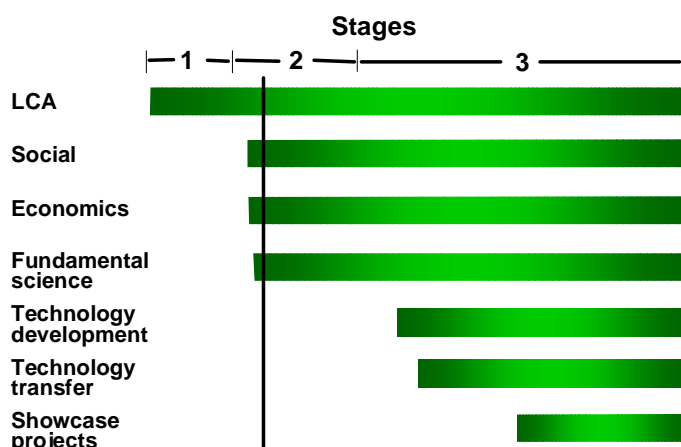
As society makes the transition to lower net Greenhouse gas emissions, the role of coal as a reductant and source of energy will change. Strategies using renewable energy sources will be progressively implemented, although these will have their own limitations. For example, they may consume resources that are far more limited than coal and employ technologies that are not cost competitive or compatible with existing social infrastructure. While there is confidence that research and technological development will, over time, lead to a new economy, there is a clear and immediate challenge - that is to deliver much more efficient and cleaner ways of extracting energy from coal. Coal remains the predominant resource in the production of steel, aluminium and electricity, which are essential elements in the fabric of society, and is expected to remain an important component of the energy mix for the next 50 years.

Decisions about the timing and direction of change in energy systems should be taken with a complete understanding of the options for achieving environmental goals through improvements in coal-based systems, as well as substitution of other energy sources. With this research information, and a good understanding of the full environmental impacts of the different fuels and technologies, it will be possible to define a least cost path to a sustainable future.

This project, Coal In a Sustainable Society, commenced as an Australian Coal Industry LCA study into steel and electricity production. This study has been expanded into a 2-year collaborative study by stakeholders (Stage 2) to include broader sustainability aspects, such as social and economic issues, as well as considering a wider range of technology options and stakeholder communications. A further Stage 3 program is presently being planned, to include technology development and transfer, and show case projects.

In Stage 1, the environmental impacts of steel and electricity production in Australia were considered using life cycle analysis (LCA) to determine Greenhouse gas emissions (GGE), fresh water consumption, SO<sub>x</sub>, NO<sub>x</sub> and SPM emissions – which includes the key issues identified in the 1999 UNEP assessment of global issues [UNEP GEO 1999]. A wider range of impacts is being considered in Stage II of the study.

The production of steel and electricity also involves production of co-products, by-products, or if no commercial application can be found, wastes. When a co-product or by-product from one process route is used to replace some other product, environmental burdens for the production of the replaced product are avoided. These system or “earth” credits have been assigned to the functional unit in the present analysis. The report is available from [www.sustainabletechnology.com.au](http://www.sustainabletechnology.com.au)



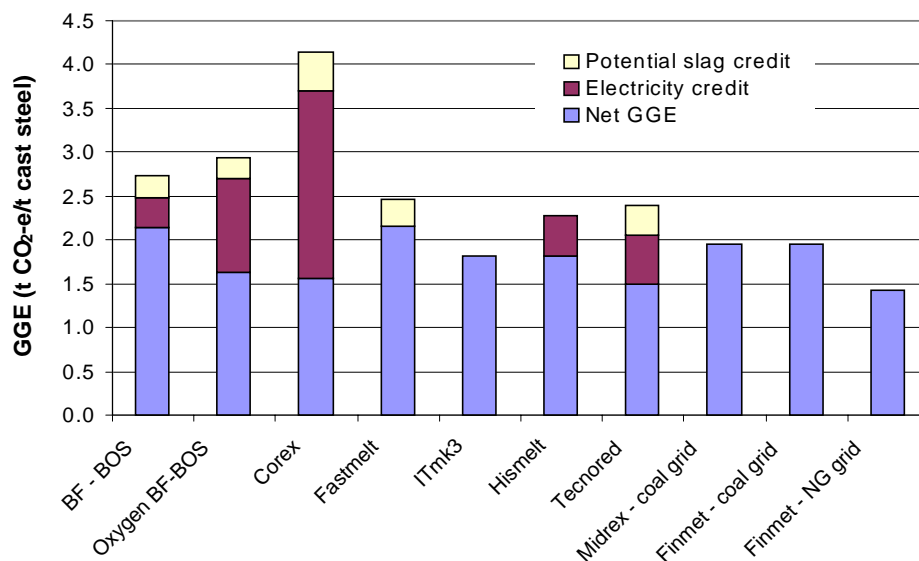
## Steel making

The results for GGE show that while conventional coal based steel production emits approximately 20% more emissions than for gas based reduction, this difference can be reduced to around 10% by utilisation of slags (produced from coal mineral matter and iron ore gangue) and

offgases. Slag utilisation is an important product stewardship issue for the coal industry and can significantly improve the economics of steel production and the environmental performance of coal.

The net GGE (with full slag and electricity credits) for the conventional integrated route (BF-BOS) of 2.1 t CO<sub>2</sub>-e/t cast steel can be compared with 1.95 t CO<sub>2</sub>-e/t cast steel for current natural gas reduction (FINMET-EAF). If natural gas is also used for EAF electricity production, then the FINMET-EAF GGE decreases to 1.4 t CO<sub>2</sub>-e/t cast steel. The advantages of integrating coal-based iron and electricity generation are significant, especially for GGE. COREX-BOS compares favourably with the gas-based routes. The magnitude of GGE credits for the coal-based processes is dependent on the GGE for grid electricity, and the energy source and technology used, and is therefore location specific.

The new and emerging coal-based technologies can match or exceed the performance of gas based technologies. However, the rate of commercialisation of these technologies remains relatively slow; most growth uses distributed EAF technology, with gas based DRI providing the virgin iron units. There is therefore a need for the coal industry to be pro-active in supporting the development of clean coal technologies for steel production; for example, with studies aimed at understanding and controlling the effects of coal properties on process fundamentals and the slags produced.

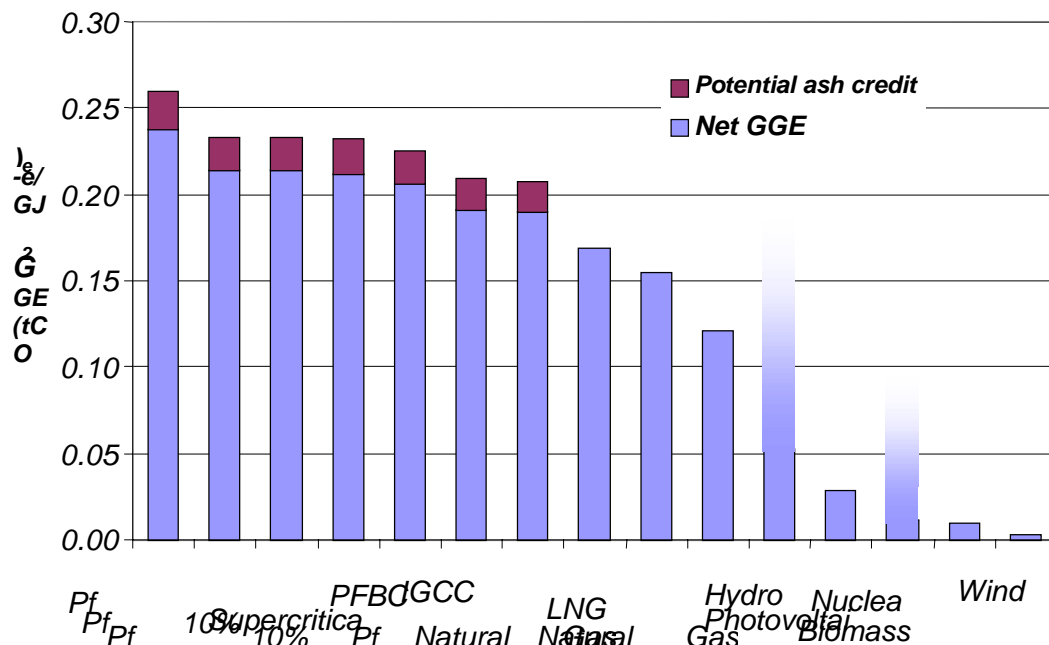


## IMPROVEMENT OPTIONS

- If all slag were used, the overall GGE (and other impacts) would decrease by at least 10%. Present utilisation of slag for cement in Australia is less than 25%. Globally, slag utilisation varies from nil to 100%. This range of utilisation, and the relatively low use in Australia, is entirely due to attitudes (there are no technical, economic or social issues, and a full account of these issues will be presented in Stage 2 of this study). This is a product stewardship issue for the coal and iron ore industries (world production of cement is 10 times that for slag).
- A substantial amount of coal is lost as tailings, which increases the resource energy consumption. The grade curves for many coals indicate that this could be improved by better integration between the coal industry and the power, steel and cement industries; *i.e.* to add value to coal mineral matter by generating a higher ash coal product for certain applications.
- To better utilise steelmaking slags, most of which are currently used for low grade applications with limited displacement value, further development is required, with a commitment from the coal, iron ore and cement industries.
- For the Port Kembla steelworks case study, coal bed methane (CBM) emissions account for around 13% of the total GGE for steel, and a significant proportion is from mine ventilation air (MVA). Globally, only 5% of this resource is utilized [Ando, Australian Coal Review April 2000], although technologies are available for utilising CBM. Technology to utilise MVA is not yet proven, although a pilot scale unit is being trialled in Australia.
- Use of some biomass (as charcoal) for coal-based steelmaking is also considered to be a practical method for reducing GGE, and is the subject of a joint State Forests - BHP project.

## ELECTRICITY PRODUCTION

While conventional pulverised coal (pf) generation has higher environmental impacts than gas-based generation (assuming low levels of well head stripping and distribution losses), the LCA study has shown that the relative difference is less than generally reported, and that there are technologies and strategies being developed that can significantly improve the position of coal - ash displacement credits, synergies with renewables, and integration with other industries.



- Most of the clean coal technologies under development have GGE which are 10-20% less than for conventional pf generation.
- The gas-based processes have lower GGE than the coal-based technologies, with the GGE for the best existing gas technologies being 45% lower than for conventional pf and 36% lower than the best clean coal technology (with ash displacement credit). Natural gas production emits wellhead CO<sub>2</sub> (data is limited) that comprises up to 15% of the total GGE for gas use for the present case studies. Much higher values have been reported for overseas natural gas production. In addition, CH<sub>4</sub> emissions from distribution losses can be significantly greater than the 0.5% used in this study – in many cases over 50% of the GGE emitted from the burner tip.
- Co-firing conventional pf with 10% biomass decreases GGE by approximately 9%, even though the study assumed 200km of road transportation for the biomass.
- Wind, solar and biomass technologies have low energy consumption and impacts. The results for PV are very dependent on cell life and the technology used to produce the wafers; this technology is likely to undergo significant improvement over time. However, the analysis excluded electricity storage; a critical long-term issue.
- The GGE for hydro is appreciable, with CO<sub>2</sub> and CH<sub>4</sub> being produced from drowned vegetation and organic inflow from the catchments. Data is limited, highly variable and depends on location. The recent report of the World Dams Commission states “Hydropower cannot be automatically assumed to emit less greenhouse gas than the thermal alternatives. Net emissions should be established on a case by case basis”.

## IMPROVEMENT OPTIONS

In addition to the clean coal technologies, the LCA work has shown that considerable improvements are possible through inter-business integration, better utilisation of flyash, and sweetening with renewables:

- Biomass co-firing with conventional pf allows the most efficient use of biomass apart from large-scale advanced combustion technologies (such as IGCC), and offers an immediate opportunity to increase the use of renewable energy. Approximately 30% biomass co-firing would be required to match natural gas on a GGE basis. This has been shown to be technically feasible in overseas studies, for both purpose grown and opportunity biomass.
- Solar thermal offers the potential to convert 40% of solar energy into electricity (*cf* 13% from PV), and at much lower capital cost than PV. This is particularly advantageous if coupled with existing steam power generation. In comparison, PV is more suited to distributed generation.
- Up to 10% reduction in the overall impacts could be obtained by the use of fly ash for cement extender. Present utilisation of fly ash (for high value/high displacement uses; *eg* cement extender or cement replacement) in Australia is less than 3% and varies from nil to 50% in some economies. Use depends on both attitudes and some technical issues. Considerably more fly ash could be utilised in Australia, either alone or in combination with slag; more development is required. This is a product stewardship issue for the coal producers and the power industry.

## SUMMARY

The LCA study shows that the performance of coal in steel making (from a Greenhouse perspective) can match gas-based routes. For electricity, the opportunity is to improve the efficiency of coal utilisation, and to use integration (with other processes and renewables) to reduce both Greenhouse emissions and other environmental impacts. The study has also provided data and identified improvement opportunities to assist the industry to position coal as an important contributor to the future reductant and energy mix.

Social and economic impacts must also be evaluated, as part of sustainability considerations. Stage 2 of the study will address these issues, as well as considering a broader range of technologies. This will provide a platform for better policy making and solutions, and will enable an appropriate communication strategy to be implemented. The purpose is not to support the status quo, but to ensure that the best transition path to lower greenhouse gas intensities and improved overall environmental performance is achieved. Policies should not be anti-coal, but support balanced, sustainable solutions to the World's energy and reductant needs.